

Appendix C – Species-specific Ecology and Proposed Treatments, Including Herbicide Rates

The following table displays species-specific ecology and integrated pest management treatments for invasive plants known to be on the Medicine Bow-Routt National Forests and Thunder Basin National Grassland and for species likely to be invaders in the future. The herbicides listed in the table are the most commonly used and rates are guidelines. In all cases, application rates would be those indicated on herbicide labels. Ongoing testing may result in new instructions on rates and target species.

A surfactant is recommended with all herbicides except some formulations of glyphosate. A methylated seed oil (MSO) is recommended with all Plateau applications for best results.

Invasive species control from post-emergent herbicides is influenced by plant community tolerance, weed species, weed size, and climatic conditions. These factors should be considered in determining the herbicide selection and rate range. The lowest rate of post-emergent herbicides will be effective under favorable growing conditions and when weeds are small and actively growing. Use the highest labeled rate under adverse conditions and for well-established weeds.

Efforts to utilize the most selective herbicide should be considered. Herbicides have a wide range of plant selectivity.

- Glyphosate (Roundup) is the least selective, affecting most plant species.
- Clopyralid (Stinger, Transline) is the most selective herbicide, affecting only plants in the sunflower (Asteraceae), buckwheat (Polygonaceae), nightshade (Solanaceae), and pea (Fabaceae) families.
- Dicamba (Banvel), picloram (Tordon), and 2,4-D amine are less specific.
- Monocots (grasses, grass-like plants, lilies, orchids and related families) are tolerant of dicamba because of rapid metabolism (Sheley and Petrof 1999); however, when mixed with other herbicides, it may be more lethal to some broad-leaved monocots.
- Picloram, 2,4-D, clopyralid and triclopyr (Remedy, Garlon 3A) can cause injury or death to forbs, trees, and shrubs but are safe for most grasses.
- Supplemental labeling for Tordon 22K (picloram) for areas west of the Mississippi River allows for wick or carpet roller applications where drift presents a hazard to susceptible crops, surface waters, and other sensitive areas. One part Tordon 22K is mixed with 2 parts water to prepare a 33% solution.
- Aminopyralid is very effective and more environmentally friendly than picloram for control of perennial and biennial thistles, and knapweeds. It can be used in riparian areas up to water's edge, but is not to be used in areas of standing water.
- Imazapic (Plateau) may be used safely around trees and over the top of many legumes and wildflowers. Some cool-season grasses may be injured or seedhead production may be inhibited. When permitted by the label, the use of methylated seed oil (MSO) surfactant will provide the best results for control, but avoid MSOs when applying to emerged seedling grasses and forbs.
- Imazapyr (Arsenal), sulfometuron (Oust), and glyphosate herbicides will control almost all vegetation sprayed. Glyphosate does not have soil residual.
- Metsulfuron (Ally, Escort) can cause injury or death to certain trees, shrubs, forbs, and grasses.

Priority 1 Species

Dalmatian toadflax (*Linaria dalmatica*) is an introduced ornamental that is quick to colonize open sites and is capable of adapting growth to a wide variety of environmental conditions. Because of its deep, extensive root system, waxy leaf, and heavy seed production, this plant is difficult to manage.

It is a tap-rooted perennial (taproot may be as long as 3 feet) with horizontal roots that may grow 25 inches per year. Adventitious root buds may form independent plants. Once established, this species can suppress other vegetation mainly by intense competition for limited soil water. Mature plants are particularly competitive with winter annuals and shallow-rooted perennials. Seeds can remain dormant for up to ten years. A single Dalmatian plant can produce up to 500,000 seeds. Seed production can begin on lower portions of the stems while upper portions are still in various stages of bloom. Dried floral stalks can remain standing for two years, retaining some seeds but dispersing most during the first year. Some Dalmatian toadflax seed germination occurs in the fall, but most occurs the following spring. Germination rates are as high as 75%, and seeds can remain dormant at least 10 years. These dormant seeds can rapidly re-infest a site following control applications, even when pre-emergent herbicides are used, because only a portion of the seeds will germinate in any given year.

Biocontrol	Effective: toadflax moth (<i>Calophasia lunula</i>), root-boring moths (<i>Eteobalia intermediella</i> and <i>E. serratella</i>) stem-boring weevil (<i>Mecinus anthinus</i>) has shown dramatic impact on Dalmatian toadflax at some locations. Not highly effective: ovary-feeding beetle (<i>Brachypterolus pulicarius</i>) flea beetle (<i>Longitarsus jacobaeae</i>) seed capsule-feeding weevils (<i>Gymnetron antirrhini</i> and <i>G. linariae</i>)	
Mechanical and cultural	Toadflax seedlings are initially very vulnerable to competition from established, vigorous vegetation. Hand-pulling must remove all roots, best in sandy or moist soils (annually, 10-15 years to eradicate). Regular cultivation. Restricting spring cattle grazing on sites with toadflax can help maintain vigorous competition from native species. Mowing and fire are not effective.	
Herbicide	Rate	Timing
Tordon	1-2 quarts per acre + surfactant * For a 3-gallon backpack: 4.5 oz per 3 gallons water + surfactant	Spring bloom & late fall post bloom
Telar	1.5 to 2.0 oz. per acre + surfactant For a 3-gallon backpack: 0.5 oz per 3 gallons water + surfactant	
Escort	2 oz. per acre + silicone surfactant	Best if used in the fall.
Escort + 2,4-D	1 to 2 oz Escort + 2 pints 2,4-D per acre +silicone surfactant	
Plateau	8 to 12 oz per/acre and MSO and silicone surfactant	Fall prior to frost

* Toadflax has a waxy leaf surface; silicone surfactant is the most important additive to any of the herbicide mixture to ensure results. Wet entire plant.

Diffuse knapweed (*Centaurea diffusa*) is a biennial or short-lived perennial with abundant seed production. A single plant can produce up to 18,000 seeds. Seeds germinate in both early spring (primarily) and fall. In the fall, diffuse knapweed breaks off at ground level and disperses widely as a tumbleweed. The allelopathic chemical may reduce recovery potential as its presence in the soil may hinder the resurgence of natives. Dormant seeds may germinate and re-infest an area.

Biocontrol	Knapweed flower weevil (<i>Larinus minutus</i>) and bronze knapweed root borer (<i>Sphenoptera jugoslavica</i>) are more effective biocontrol agents than the following agents: seed head gall fly (<i>Urophora affinis</i>); seed head gall fly (<i>U. quadrifasciata</i>); peacock fly (<i>Chaetorellia acrolophi</i>); seed head weevil (<i>Bangasternus fausti</i>); root weevil (<i>Cyphocleonus achates</i>). None of these, alone or in combination effectively control populations. They may prove useful as part of an integrated program to weaken plants therefore making them more susceptible to other treatments.	
Mechanical and cultural	Hand-pulling of small infestations usually must be repeated for 7 to 10 years. Dig rosettes in the spring. Pull mature and immature plants in early summer before seeds form. Pull and bag (to remove seed from area) remaining plants in mid to late summer. All of the infestation must be pulled. All of the taproot must be removed. Mowing could increase populations of this species. Grazing is not an effective control method. It is generally unpalatable and the spines can injure livestock. Fire may be effective in controlling this species. Low-severity fire may only top-kill diffuse knapweed. Dry soil conditions associated with burns may discourage re-infestation as moisture is the limiting factor for seed germination. Reseeding of desirable species may be necessary. The fuel model developed for spotted knapweed may be useful to managers planning to burn infestation of diffuse knapweed.	
Herbicide	Rate	Timing
2,4-D	2 quarts per acre + surfactant For a 3-gallon backpack: 4.5 oz per 3 gallons water	Actively growing (early rosette stage) in the spring, bolt to early bud, or during fall growth
Tordon	1 pint per acre + surfactant For a 3-gallon backpack: 1.5 to 2 oz per 3 gallons water	
Tordon + 2,4-D	1 pint Tordon + 1 quart 2,4-D per acre + surfactant For a 3-gallon backpack: 1.5 oz Tordon + 2.25 oz 2-4D per 3 gallons water	
Banvel + 2,4-D	1 pint Banvel + 2 pints 2,4-D per acre + surfactant	
Milestone	5-7 oz. per acre	
Transline	1/3 to 1 1/3 pints per acre + surfactant For a 3-gallon backpack: 1.5 oz per 3 gallons water	

Leafy spurge (*Euphorbia esula*) occurs on untilled, non-cropland habitats, including both disturbed and undisturbed sites, especially abandoned cropland, pastures, rangelands, woodlands, roadsides, and waste places. It tolerates a wide range of soils from rich, moist soils of riparian zones to nutrient-poor, dry soils of western rangelands. It is most aggressive in semi-arid situations where competition from associated species is less intense.

Perennial and rhizomatous. Reproduces by seed (viable up to 8 years, usually germinate within 2 years), and spreading roots. Each flowering stem produces an average of 140 seeds. When the plant matures, the seed capsule explodes and launches the seeds up to 15 feet. Seed production ranges from 25 to 4,000 pounds per acre depending on plant density and site productivity. Seedlings have capacity for vegetative reproduction and can develop root buds with 7 to 10 days of emergence. Roots as long as 35 feet have been found. Root systems of well-established older plants can regenerate from fragments even if roots are removed to a depth of three feet.

Leafy spurge can cause blistering and hair loss around horses' hooves and can be irritating to the skin, eyes and digestive tracts of humans and other animals.

(http://plants.usda.gov/plantguide/pdf/pg_eues.pdf)

Biocontrol	Flea beetle (<i>Aphthona abdominalis</i>), flea beetle (<i>A. nigriscutis</i>), flea beetle (<i>A. lacertosa</i>), flea beetle (<i>A. czwalinae</i>), flea beetle (<i>A. cyparissiae</i>), flea beetle (<i>A. flava</i>), hawk moth (<i>Hyles euphorbiae</i>), long horned beetle (<i>Oberea erythrocephala</i>), gall midge (<i>Spurgia esulae</i>) Some success has been found with the flea beetle combined with fall herbicide treatments.	
Mechanical and cultural	No mechanical methods have been found to work effectively alone. Hand-pulling, digging, and tilling are only successful if the entire root system can be excavated, and may increase the number of plants if any remnants remain in the soil. Repeated mowing/cutting before flowering in conjunction with use of herbicides may be adequate control of stand expansion. Mowing is ineffective when used alone. However, it does reduce seed production and dispersal and disrupts root vigor, making the plants more susceptible to pathogens. Mowing increases the effectiveness of herbicides by making the stand of leafy spurge more uniform improving the coverage of the chemical treatment. Grazing by sheep or goats can be a very effective tool for controlling leafy spurge populations. Leafy spurge is not toxic, and in fact, is very nutritious, providing good forage. Light, periodic cultivation stimulates additional plants from the roots resulting in a denser stand. Initial reseeding with grasses followed by eventual revegetation with forbs and shrubs may contribute to long-term suppression of leafy spurge. Burning, alone, is ineffective for reducing leafy spurge infestations, and it stimulates sprouting of established plants, increasing plant density. Spring or fall burns are best when trying to control seed production and is more effective when used in conjunction with herbicides or grazing.	
Herbicide	Rate	Timing
Tordon	1 to 3 quarts per acre + surfactant For 3-gallon backpack: 4.5 to 6.5 oz per 3 gallons water	Before seed set or during fall regrowth

Tordon + 2,4-D	1 pint Tordon + 1 quart 2,4-D + surfactant For 3-gallon backpack: 2.25 oz Tordon + 2.25 oz 2- 4D per 3 gallons water	During true flowering
Plateau	8-12 oz per acre +surfactant	Late fall before leafy spurge loses its milky sap after a killing frost

Russian knapweed (*Acroptilon repens*) prefers heavy, often saline soils of bottomlands and sub-irrigated slopes and plains. Commonly found along roadsides, riverbanks, irrigation ditches, pastures, waste places, clearcuts, croplands, and hayfields. Does not readily establish in healthy native vegetation, requires disturbance. Once established, it emits allelopathic compounds to inhibit other plants. Long-lived perennial (75 years). A single plant may produce 1,200 seeds, which remain viable two to three years. Although Russian knapweed produces seeds, it does not reproduce extensively from seed. Infestations increase primarily vegetatively through adventitious buds on a creeping root system. The vertical and horizontal roots may be black with a scaly appearance. Roots grow 6 to 8 feet deep the first season and 16 to 23 feet deep in the second season.

Russian knapweed can sometimes develop resistance to many chemical formulations. Sulfonylureas inhibitors such as Escort, Telar, Oust, Glean, Plateau, or Tordon are recommended for use.

Biocontrol	Gall-forming nematode (<i>Subanguina picridis</i>), seed head gall fly (<i>Urophora quadrifasciata</i>), seed head gall fly (<i>U. affinis</i>),	
Mechanical and cultural	Cultivation, cutting/mowing, and/or hand- pulling not recommended unless done three times per year (spring, summer, fall) to force the plants to use nutrient reserve stored in roots, followed by herbicide treatment. This protocol must be followed for at least 3 years otherwise it will stimulate sprouting from rhizomes. It is difficult to remove all roots with a one-time effort. Severed root pieces as small as 2.5 cm can generate new shoots from depths to 15 cm. Whichever control combination is chosen, it is imperative to continually stress the plant because it does not do well under stressful conditions. The most preferred method of control is to mow the area of Russian knapweed once a month during the spring and summer months, then follow up with an application of Tordon or 2,4-D in the fall. Chemicals are not always necessary if the plant is stressed by mechanical methods and proper cultural techniques are applied. Long-term reductions must include planting competitive plant species to occupy bare ground once infested by the weed, due to Russian knapweed's allelopathic qualities.	
Herbicide	Rate	Timing
Tordon	2 quarts per acre For 3-gallon backpack: 4.5 oz per 3 gallons water	Before full flower or during fall re- growth
Telar	1 1/3 pints per acre For 3-gallon backpack: 0.5 oz. per 3 gallons water	
Transline	2 oz. per acre	
Milestone	4-6 oz. per acre	

Saltcedar (*Tamarisk complex*) is a deciduous shrub that can grow up to 15 feet in height. It is found in many riparian areas throughout the West. It was introduced as an ornamental and for erosion control. It out-competes native riparian trees by forming deep root systems that can remove underground water not available to native species. It invades streambanks, sandbars, lake margins, wetlands, moist rangelands and saline environments. It can crowd out native riparian species, diminish early succession, and reduce water tables, thus interfering with hydrological processes. It reproduces by seed (can produce over 500,000 seeds) and from stems, crown and roots.

Biocontrol	Mealy bug (<i>Trabutina mannipara</i>), leaf beetle (<i>Diorhabda elongata</i>)	
Mechanical and cultural	New growth occurs readily when young plants are grazed or mowed, or the trunk or shoots are removed or killed by fire or severe drought. Establish and maintain native vegetation to prevent infestation or re-infestation.	
Herbicide	Rate	Timing
Rodeo aquatic	Per acre rate: 7 1/2 pts./ac plus 1/2%v/v nonionic surfactant Spot treatment: 11 1/2% v/v solution plus 1/2% v/v nonionic surfactant Cut stump treatment: 100% v/v solution (full strength)	August through September
Roundup Pro	Per acre rate 5 qts/ac Spot treatment: 2% v/v solution Cut stump treatment: 100% v/v solution (full strength)	
Arsenal	Per acre rate: 1.5 to 2 qt/ac w/ MSO adjuvant Spot treatment: 1 gal per 100 gal water + 0.25% surfactant Cut stump treatment: 12 oz per gallon of water Thoroughly wet foliage. Do not cut down and remove for at least 3 years or re-growth will occur.	
Garlon and Pathfinder II	Foliar treatments: 2 to 4 qt/ac Modified cut stump treatments: undiluted Pathfinder II or 50% solution of Garlon 4 or 3A. Basal bark treatments: undiluted Pathfinder II or a 20 - 25% solution of Garlon 4 in natural oil or diesel or 1 -3 parts Remedy plus basal bark oil Volatility of triclopyr (Garlon and Pathfinder II) at higher ambient temperatures could lead to undesirable effects on adjacent vegetation.	There are no timing restrictions for application of Garlon 4 or Pathfinder II. Garlon 3A should be applied during the growing season.

Spotted knapweed (*Centaurea maculosa*) is best adapted to well-drained, light-textured soils in areas that receive some summer rainfall. This includes ponderosa pine and Douglas-fir forests and shrub-steppe habitats with bluebunch wheatgrass, needle-and thread, and Idaho fescue. The biggest enemy of spotted knapweed is irrigation or wetter-than-normal areas. Once established, it emits allelopathic compounds to inhibit other plants. The roots give off a chemical reaction that kills other plants surrounding it. This then leaves bare ground for new knapweed plants to sprout and grow, increasing size and density of an infestation and eventually resulting in a monoculture of knapweed.

Biennial or short-lived perennial. Each plant can produce 400 or more seeds per flower stalk and up to 40,000 seeds per plant. Most seeds fall within a 3 to 4 foot radius of the parent plant. Seeds are viable for 7 to 20 years and germinate throughout the growing season. Typically, the species bolts during its second growing season but plants may stay in the rosette stage for multiple years before bolting

Biocontrol	Seed head gall fly (<i>Urophora affinis</i> and <i>U. quadrifasciata</i>), seed head fly (<i>Chaetorellia acrolophi</i>), seed head moth (<i>Metzneria paucipunctella</i>), seed head weevil (<i>Bangasternus fausti</i>), seed head weevil (<i>Larinus minutus</i> and <i>Larinus obtusus</i>), black leaf blight fungus (<i>Alternaria alternata</i>), root moth (<i>Agapeta zoegana</i>), verdant seed fly (<i>Terellia virens</i>), root weevil (<i>Cyphocleonus achates</i>), fungus (<i>Sclerotinia</i>). The most promising bio-agents are the two seed head attacking flies <i>Urophora affinis</i> and <i>U. quadrifasciata</i> .	
Mechanical and cultural	Hand-pulling of small infestations (usually takes 7 to 10 years). The entire root crown must be completely removed. In stands with little other vegetation, it may be possible to mow if mowing occurs just after most flowering has ended, but before seeds have matured. Mowing combined with mulching may increase effectiveness. Mowing may cause low growing forms. It is considered moderately effective. Long-term grazing by sheep and goats has been found to control spotted knapweed. Sheep, goats, and cattle will consume spotted knapweed without any adverse effects. Generally this can be an effective method if it coincides with cultural practices and proper grazing management practices are used. Prescribed burning alone is probably not effective for controlling spotted knapweed and may cause increases. Studies have shown moderate increases after fire. Established stands may be reduced by hot, prescribed burns. Fire may be useful in conjunction with herbicides under the right conditions by reducing old stem densities. A fuel model has been developed for this species. The fire severity depends on the amount of dry knapweed stems and the amount of fine grass fuels. Plowing soils under to 7 inches, allowing 4-6 weeks for re-germination and then repeating for one growing season has been successful. Herbicide application may make cultivation more effective for large infestations. For cultural controls, desired grasses should be planted during the fall to maximize establishment success.	
Herbicide	Rate	Timing
2,4-D	2 quarts per acre For a 3-gallon backpack: 4.5 oz per 3 gallons water	Actively growing (early rosette stage) in the spring, bolt to early bud, or during fall growth.
Tordon	1 pint per acre For a 3-gallon backpack: 1.5 to 2 oz per 3 gallons water	

Tordon + 2,4-D	1 pint Tordon + 1 quart 2,4-D per acre For a 3-gallon backpack: 1.5 oz Tordon + 2.25 oz 2,4-D per 3 gallons water	Actively growing (early rosette stage) in the spring, bolt to early bud, or during fall growth.
Milestone	5-7 oz. per acre	
Transline	1 1/3 pints per acre For a 3-gallon backpack: 1.5 oz per 3 gallons water	

Squarrose knapweed (*Centaurea virgata ssp squarrosa*) prefers dry, open rangeland with shallow soils. Areas most susceptible are sagebrush and pinion-juniper rangelands. It readily invades and becomes established on rangelands with little herbaceous understory and even in crested wheatgrass seedings, particularly after fire. It can survive harsh climates and is tolerant of fire and drought. This weed is rarely found on croplands or irrigated pasture because it cannot survive cultivation or excessive moisture from irrigation.

Biocontrol	Knapweed flower weevil (<i>Larinus minutus</i>) and bronze knapweed root borer (<i>Sphenoptera jugoslavica</i>) are more effective biocontrol agents than the following agents: seed head gall fly (<i>Urophora affinis</i>); seed head gall fly (<i>U. quadrifasciata</i>); peacock fly (<i>Chaetorellia acrolophi</i>); seed head weevil (<i>Bangasternus fausti</i>); root weevil (<i>Cyphocleonus achates</i>) None of these alone, or in combination, effectively control populations. They may prove useful as part of an integrated program to weaken plants therefore making them more susceptible to other treatments.	
Mechanical and cultural	Hand pulling squarrose knapweed is ineffective because stout taproots re-sprout when broken off. Grubbing or digging the roots of individual plants or small infestations of squarrose knapweed with a shovel may be effective if most of the taproot is removed. The root should be cut at least eight inches below the soil surface in order to prevent the formation of new shoots.	
Herbicide	Rate	Timing
2,4-D	2 quarts per acre + surfactant	Apply to actively growing plants in the bud stage
Tordon	1 pint per acre + surfactant	
Tordon + 2,4-D	1 pint Tordon + 1 quart 2,4-D per ac + surfactant	
Banvel + 2,4-D	1 pint Banvel + 2 pints 2,4-D per acre + surfactant	Late spring before or during flower stem elongation
Milestone	5-7 oz. per acre	
Transline	1/3 to 1 1/3 pints per acre + surfactant	

Yellow toadflax (*Linaria vulgaris*), like Dalmatian toadflax, is an introduced ornamental that is quick to colonize open sites and is capable of adapting growth to a wide variety of environmental conditions. It is a perennial. Flowers produce capsules containing 10 to 40 seeds each. The fruit is round, about 1/4 inch in diameter and brown. A single plant may produce 15,000 to 30,000 seeds. Seed germination rates are usually low, often below 10%. It is a tap-rooted perennial (taproot may be as long as 3 feet) with horizontal roots that may grow 25 inches per year. Adventitious root buds may form independent plants. Once established, this species can suppress other vegetation mainly by intense competition for limited soil water. Mature plants are particularly competitive with winter annuals and shallow-rooted perennials. Seeds can remain dormant for up to ten years.

Biocontrol	None of these are considered highly effective: toadflax moth (<i>Calophasia lunula</i>), root-boring moths (<i>Eteobalia intermediella</i> and <i>E. serratella</i>), seed capsule-feeding weevils (<i>Gymnetron antirrhini</i> and <i>G. linariae</i>), stem-boring weevil (<i>Mecinus janthinus</i>), ovary-feeding beetle (<i>Brachypterolus pulicarius</i>), flea beetle (<i>Longitarsus jacobaeae</i>).	
Mechanical and cultural	Hand-pulling must remove all roots, best in sandy or moist soils (annually, 10-15 years to eradicate). Regular cultivation (every 7 to 10, for 2 years). Do not mow. Fire is not effective. Intense competition with native vegetation. Because established infestations of yellow toadflax spread mainly by roots, physical removal (especially around perimeters) can limit spread.	
Herbicide	Rate	Timing
Tordon	4 pints Tordon per acre+ a silicone surfactant For 3-gallon backpack: 4.5 oz per 3 gallons water; Use a silicone surfactant.	Before seed set.
Fall applications of Tordon give partial control. Dicamba + 2,4-D, chlorosulfuron, or metsulfuron methyl + 2,4-D gives good control when applied before the bloom stage. 2,4-D alone can be effective but will likely require repeated applications.		

Priority 2 Species

Black henbane (*Hyoscyamus niger*) is found in disturbed open sites, roadsides, fields, waste places, and abandoned gardens. Grows best in sandy or well-drained loam soils with moderate fertility. Does not tolerate waterlogged soils. Poisonous to most mammals. As an annual or biennial, black henbane relies on prolific seed production. A single plant can produce up to half a million seeds.

Biocontrol	None currently available	
Mechanical and cultural	Hand-pulling, mowing, or digging to prevent seed production is effective. The tap root must be removed to kill the plant. Burning mature plants will kill the seed. Can be controlled with regular cultivation.	
Herbicide	Rate	Timing
Tordon	1 to 2 pints per acre	Actively growing, prior to seed set

Bull thistle (*Cirsium vulgare*) occurs in dry to moist habitats, fields, pastures, grasslands, roadways, forest clearings, rock outcrops, and along waterways. It is not shade tolerant. A biennial, bull thistle relies on short-lived seed (viable for 3 years or less) for regeneration.

Biocontrol	Gall fly (<i>Urophora stylata</i>)	
Mechanical and cultural	Hand-pulling, mowing, burning, digging will kill if above ground portions of the plant are completely removed or consumed because it does not sprout from the root crown or root. If 8 inches or more of the stem remains alive, it may sprout from remaining portions of the stem. The presence of tall herbs reduces bull thistle seedling survival, so revegetation with desirable species is an important part of control.	
Herbicide	Rate	Timing
Tordon + 2,4-D	1 pint Tordon + 1 quart 2,4-D per acre	Before seed set or during fall regrowth
Milestone	3-5 oz per acre	

Cheatgrass (*Bromus tectorum*) and Japanese brome (*Bromus arvensis*): Although annual bromes can be found in both disturbed and undisturbed shrub-steppe and grasslands, the largest infestations are usually found in disturbed shrub-steppe areas, overgrazed rangeland, abandoned fields, eroded areas, sand dunes, road verges, and waste places. Annual bromes are winter annuals; as such they are dependent on seed production for reproduction. They are prolific seed producers, able to produce enough seed to perpetuate themselves even under unfavorable growing conditions.

Biocontrol	None currently available. Two rhizobacteria, <i>Pseudomonas fluorescens</i> (strain D7), and <i>P. syringae</i> (strain 3366), are under study.	
Mechanical and cultural	Cutting is not recommended. Disking and other mechanical control methods applied alone are often ineffective. A combination of methods is needed: deep disking several times at intervals to bury seeds 4 to 6 inches then overseeding or shallow disking to initiate seed germination, then either disking again or spraying with glyphosate, followed by broadcast or drill seeding. Sites must be revegetated with perennial grasses with an established groundcover of 15-25%. Burning is an ineffective method for controlling cheatgrass due to its prolific seed production. Livestock grazing can be purposely manipulated to control cheatgrass. Plants must be grazed before they turn purple in color. At least two defoliations are needed in the spring of each year for at least two consecutive years and there must be an existing stand of native perennial grasses.	
Herbicide	Rate	Timing
Glyphosate	2 to 4 oz per acre	Early to pre-root development. Apply in early spring when the plants are growing vigorously.
Oust	3 to 5 oz/acre (0.2-0.3 lb./acre)	Apply after fall germination
Plateau	2 oz/ac to 12 oz/acre 2 to 6 oz/ac of Plateau are recommended for bare soil, with light infestations. In areas of thick vegetation and leaf litter, higher rates of 6 to 12 oz/ac may be needed.	Fall, pre-emergent to germination.

Common tansy (*Tanacetum vulgare*) is a perennial herb in the sunflower family. This species, native to Europe, has a long history of medicinal use. It was first introduced to North America for use in folk remedies and as an ornamental plant. Common tansy is an invader of disturbed sites and is commonly found on roadsides, fence rows, pastures, stream banks and waste areas throughout North America. Common tansy spreads mainly by seeds, and less commonly from creeping rhizomes, to form dense clumps of stems.

Biocontrol	None currently available.	
Mechanical and cultural	Hand-pulling not recommended (stimulates sprouting from rhizomes) and must remove all roots. Constant cultivation, otherwise the infestation can increase by chopping roots that sprout. Mowing to reduce seed production. Grazing by sheep and goats. Revegetation for shade.	
Herbicide	Rate	Timing
Tordon	2 pints per acre For a 3-gallon backpack: 2 oz per 3 gallons water	Before flowering
Tordon + 2,4-D	1 pint Tordon + 1 quart 2,4-D per acre For a 3-gallon backpack: 1 oz Tordon + 2.25 oz 2,4-D per 3 gallons water	
Escort	1 oz per acre	

Hoary cress, whitetop (*Cardaria draba*) is found in non-shaded, disturbed conditions, including roadsides, waste places, fields, gardens, feed lots, watercourses, open grasslands, and along irrigation ditches. Not particular about soil type, even saline soils, except for highly acidic soils. Most aggressive, rapid expansion occurs in irrigated conditions or during moist years. Whitetop is one of the earliest perennial weeds to emerge in the spring. If conditions remain suitable, it will flower and produce a second crop of seeds late in the summer. A single plant can produce from 1,200 to 4,800 seeds each year. Buried seeds remain viable for about three years. Whitetop is a deep-rooted perennial, with roots going 12 to 30 feet deep. One plant can spread 12 feet in its first year.

Biocontrol	None currently available	
Mechanical and cultural	Manual, mechanical, and cultural control practices yield little success. Mowing or grazing with sheep or goats during bud stage and again during re-bud (followed by herbicide). Hand-pulling or digging must remove all roots and continue for 2 to 5 years to eradicate. Presence of competing vegetation, particularly shrubs, vetch, lupine, and other nitrogen-fixing legumes will help suppress whitetop.	
Herbicide	Rate	Timing
Escort	0.5 to 1 oz per acre + surfactant	Treat prior to or at early flowering and fall regrowth
Telar	3/4 to 1 oz per acre + silicone surfactant	
Plateau	8 to 12 oz per acre + MSO	
Banvel + 2,4-D	1 quart Banvel + 1 quart 2,4-D per acre + surfactant For 3-gallon backpack: 2.25 oz Banvel + 2.25 oz 2,4-D + surfactant	Pre-bloom

Musk thistle (*Carduus nutans*) does best in disturbed areas, such as along roadsides, grazed pastures, burned areas, and old fields but also can invade deferred pastures and native grasslands. It can occur in almost all habitats except dense forests, high mountains, deserts, and frequently cultivated farmlands. It is a biennial or winter annual, reproducing by seed. It is a very prolific seed producer, producing a few thousand to 100,000 seeds per plant. Most seeds fall close to the plant, resulting in thousands of new seedlings in the immediate area. Musk thistle seeds may remain viable for more than 10 years in the soil.

Biocontrol	Rosette weevil (<i>Trichosirocalus horridus</i>), flea beetle (<i>Psyllodes chalconera</i>), syrphid fly (<i>Cheilosia corydon</i>), thistle-defoliating beetle (<i>Cassida rubiginosa</i>).	
Mechanical and cultural	<p>Mechanical control is effective on musk thistle. Tilling, hoeing, and hand-pulling must be completed either in the rosette stage or early after the flower stalk bolts, but before the plant flowers and produces seed. To be effective, a successful revegetation program must follow tilling. If this is not done, re-infestation of musk thistle is inevitable.</p> <p>Mowing is an option, but it can allow some musk thistle plants to recover and possibly sow seeds. Mowing does reduce seed production but should not be the single means of control in a management program. It is most effective at the flower bud stage. Mowing combined with an herbicide is more effective.</p> <p>Good forage management practices that establish competitive desirable forage, maintain soil fertility, and prevent erosion will help combat musk thistle.</p> <p>Research shows that musk thistle has declined over the years when perennial grasses are present.</p>	
Herbicide	Rate	Timing
Tordon + 2,4-D	1 pint Tordon + 1 quart 2,4-D per acre	Before seed set or during fall regrowth
Transline	2/3 pint per acre	
Banvel	1 to 1 1/2 pints per acre	
Milestone	3-5 oz. per acre	

Russian olive (*Elaeagnus angustifolium*) is a native of southern Europe and western Asia. It was introduced into the United States in the early 1900s as an ornamental and specimen for wind-row plantings. It is a perennial deciduous tree (or shrub) that grows to heights of 10 to 25 feet. The seeds are ingested by birds or gathered by small mammals and then deposited elsewhere. The seeds can remain viable for up to three years and can germinate over a broad range of soil types. The tree itself tolerates a wide range of soil and moisture conditions from sand to heavy clay and can withstand flooding, silting and drought. Russian olives are deep-rooted and have well-developed lateral root systems. Although the tree reproduces primarily by seed production, it can establish vegetatively by sprouting from buds on the root crown and sending up root suckers. It has a medium to rapid growth rate and can grow up to six feet per year.

Biocontrol	There are no registered biocontrol agents for Russian olive.
Mechanical and cultural	Cutting alone is not enough to control this tree. Russian olive is a vigorous resprouter from the root crown and will rapidly regrow following cutting or any type of top growth damage. Small seedlings may also be hand pulled in the spring and early summer, but this is extremely difficult when stems are greater than one-half inch in diameter. Resprouts from older root crowns cannot be hand pulled at all. In addition to the sprouts, control efforts will need to continue until the seed source within the soil is exhausted, which may take several years.

Herbicide	Rate	Timing
Roundup	2 cc (ml) per inch of trunk diameter or 5% solution applied to foliage	Apply undiluted to frill cuts or apply to foliage after the tree fully leafs out.
Arsenal	2 cc (ml) per inch of trunk diameter or 0.75% solution of the 2 lb ai/gal applied to foliage	

Scentless chamomile (*Tripleurospermum perforatum*) is an annual, biennial, or short-lived perennial that reproduces by seed. This weed is found in roadsides, drainage ditches, fence lines, various croplands, hay lands, pastures, farmyards and wastelands. It is more prevalent on disturbed sites. Scentless chamomile reproduces only by seed. Abundant seed production and variable dispersal methods are this weed's key to success. A single plant can produce as many as a million seeds. Most scentless chamomile seedlings establish in the spring or fall. The seed does not have a dormancy period. New seed requires light to germinate and will not germinate if buried in the soil. With time, scentless chamomile seed loses its requirement for light and will germinate in the dark. Buried seed can remain viable up to 15 years.

Biocontrol	None available	
Mechanical and cultural	Frequent, shallow tillage can help exhaust the seed bank in non-native areas. Mowing is not an effective long-term control method due to the fact the plant will prostrate, in the short-term mowing will assist with limiting seed production. Hand pulling can prevent spread into new areas and is effective on small infestations.	
Herbicide	Rate	Timing
Escort XP	0.33 oz product/ac + 0.25% v/v non-ionic surfactant	Apply when plant is in rosette to bolting growth stage
Telar	0.33 oz product/ac + 0.25% v/v non-ionic surfactant	
Milestone	7 oz product/ac + 0.25% v/v non-ionic surfactant	

Scotch thistle (*Onopordum acanthium*): Like bull and musk thistles, Scotch thistle is a biennial, relying on seed production for proliferation. Requiring adequate moisture for establishment, Scotch thistle is often associated with waterways in the western United States. It can also occupy dry sites.

Biocontrol	Seed head weevil (<i>Rhinocyllus conicus</i>), thistle crown-weevil (<i>Trichosirocalus horridus</i>)	
Mechanical and cultural	Digging must cut plant off below soil level, leaving no above-ground biomass. Establishing and maintaining dense, vigorous native vegetation is especially important to reduce seed germination (particularly in the fall). Grazing regimes should be adjusted to avoid late summer/fall rotations.	
Herbicide	Rate	Timing
Tordon + 2,4-D	1 pint Tordon + 1 quart 2,4-D per acre	Before seed set or during fall regrowth
Milestone	5 -7 oz. per acre	

St. Johnswort (*Hypericum perforatum*) is a taprooted perennial weed which reproduces by seeds and short runners. The taproot may reach depths of 4 to 5 feet. Lateral roots grow 2 to 3 inches beneath the soil surface but may reach depths of 3 feet. Flowering begins in May and continues through September. Developing capsules become very sticky and contain 400 to 500 seeds. Seeds may remain viable in soil for up to 10 years.

Biocontrol	Beetle (<i>Agrilus hyperici</i>), moth (<i>Aplocera plagiata</i>), beetle (<i>Chrysolina hyperici</i>), beetle (<i>C. quadrigemina</i>), Klamath weed midge (<i>Zeuxidiplosis giardi</i>). The Klamath weed beetle has had good success and another beetle (<i>C. hyperici</i>) is better adapted to wetter sites.	
Mechanical and cultural	Hand-pulling or digging of young, isolated plants. Repeated treatments will be necessary because lateral roots can give rise to new plants. Pulled or dug plants must be removed from the area to a refuse site or burned to prevent vegetative regrowth. Cutting and mowing not recommended - may reduce seed but promotes sprouting from rhizomes. Burning may increase the density and vigor of this species. Livestock avoid this species which can make them sensitive to sunlight, so grazing would select for the increase of this species. Regular cultivation. Maintain a competitive, closed-canopy plant community. This species is not shade tolerant	
Herbicide	Rate	Timing
Tordon	1 pint per acre	Pre-bloom
2,4-D	1 quart per acre Repeated applications necessary	Seedling/pre-bloom

Sulphur cinquefoil (*Potentilla recta*) is a long-lived, taprooted perennial herb that typically flowers from late May to mid July. It reproduces primarily through seed; a single plant can produce thousands of seeds annually and it can be spread by roots if they are moved by tillage or on soil-moving equipment. Seeds are dispersed primarily by wind from late summer through fall. Seeds appear to remain viable in the soil for more than four years, though studies specifically addressing seedbank persistence are lacking. In western North America, sulfur cinquefoil invades native forest, shrub and grassland plant communities as well as disturbed habitats that typically harbor weeds. It can dominate a site within 2 to 3 years. New shoots can develop annually from the outer portion of the main root allowing a plant to live for extended periods as long as 20 years

Biocontrol	Root moth (<i>Tinithia myrmosae-formis</i>), flower-head weevil (<i>Anthonomus rubripes</i>) Sulfur cinquefoil is closely related to the desirable northern cinquefoil, the wild strawberry, and tame strawberry. Therefore, plant-specific insects for biocontrol are very difficult to find.	
Mechanical and cultural	Hand-pulling of small infestations (must remove root crown). Regular cultivation. Mowing not recommended. Burning used alone does not appear to be effective, and may in fact increase sulfur cinquefoil recruitment. If populations are reduced (e.g., by herbicide, hand-digging), native plants are usually able to rapidly recolonize sites if sufficient native seed is still viable in the soil. Seeding of native species under adequate environmental conditions, reducing grazing pressure, and continued spot herbicide re-treatments will result in a more rapid and stable restored native plant community.	

Herbicide	Rate	Timing
Tordon + 2,4-D	1 pint Tordon + 1 quart 2,4-D per acre For a 3-gallon backpack: 1 oz Tordon + 2.25 oz 2,4-D per 3 gallons water	Before seed set and during fall regrowth
Escort	0.5 to 1 oz per acre For a 3-gallon backpack: 2/10 oz per 3 gallons water	
Milestone	4 to 6 oz per acre	

Priority 3 species

Canada thistle (*Cirsium arvense*) prefers, and is invasive in, prairies and other grasslands and riparian areas with deep, well aerated, mesic soils, but also occurs in almost every upland herbaceous community, especially roadsides, abandoned fields, and pastures. Perennial and rhizomatous. Reproduction by seeds and shoots from lateral roots. Dormant, buried seeds can remain viable for up to 26 years. It readily roots from fragments less than an inch in length. Canada thistle differs from other species of the true thistle in that there are male and female flower heads on separate plants. By asexual reproduction, it is possible that a colony of male plants would produce no fruits but still maintain itself. A Canada thistle shoot can produce as many as 100 heads in a season, with each head containing as many as 100 seeds. Horizontal root growth can extend more than 19 feet in one season and may eventually penetrate into the soil as deep as 22 feet. A one-year growth study showed a root segment had grown 1,700 feet of roots and turned into a 142-plant colony. The thistle root averaged 2.5 feet of root growth per day.

Biocontrol	Stem-boring beetle (<i>Centorhyncus litura</i>), gall fly (<i>Urophora cardui</i>), shoot fungus (<i>Sclerotinia sclerotiorum</i>), seed head weevil (<i>Larinus planus</i>), defoliating beetle (<i>Cassida rubiginosa</i>). Overall, this method provides little or no control, although some agents weaken and kill individuals. Most biocontrols are not adequately synchronized with the thistle's life cycle in North America. Management that delays flowering, such as mowing or burning, may help to synchronize a more susceptible stage with bio-control agent's life cycle. At least three agents may be needed for effective control.
Mechanical and cultural	Removing flowers to prevent seed production may reduce spread by seed but the species reproduces primarily by vegetative means. Cultivation is not recommended. Mowing may only be effective in rare cases where it can be repeated at monthly intervals. This intensity is not recommended in natural areas, where it would likely damage native vegetation, but it may be practical along roadsides. When mowing, cut high enough to leave >9 leaves per stem, or > 20 centimeters of bare stem tissue, as mature Canada thistle leaves and stems independently inhibit development of shoots from rootbuds. Smothering Canada thistle with boards, sheet metal or tar paper can kill plants.

Mechanical and cultural, cont.	<p>Above ground parts will be killed by fire, but below ground parts will survive even severe fires. There is abundant evidence that post-fire establishment of Canada thistle is common where seed source is available. Results are mixed on the use of prescribed fire as a management tool. Prescribed burns may be effective at stimulating growth of native species and thereby discouraging the growth of this invasive. It may be best if timed to emulate the natural fire regime of a site. Late spring burns may discourage the species, yet early spring burns may encourage it. Dormant season burning may be preferred because it stimulates growth of native vegetation, but may not be as effective as late spring burning. Annual burns for several years may be required.</p> <p>Hand pulling or grubbing is not considered to be an economically effective means of controlling an established stand of Canada thistle.</p>	
Herbicide	Rate	Timing
Tordon + 2,4-D	1 quart Tordon + 1 quart 2,4-D per acre In a 3-gallon backpack: 1 oz Tordon + 2.25 oz 2,4-D per 3 gallons water	Before seed set or during fall regrowth
Escort	0.75 to 1.0 oz per acre In a 3-gallon backpack: 3/10 oz per 3 gallons water	
Banvel + 2,4-D	1.5 pints Banvel + 2 pints 2,4-D per acre + surfactant	
Rodeo (in wetlands)	1 quart per ac + LI700 surfactant	
Telar	1.5 oz per acre	
Milestone	5-7 oz. per acre	
Transline	2/3 pint per acre	Up to bud stage

Common burdock (*Arctium minus*) is commonly found growing along roadsides, ditchbanks, in pastures and waste areas. The burs can become entangled in the hair of animals allowing seed to be distributed to new areas. A biennial, common burdock reproduces by seed only. Seed is generally considered to be viable for two years (although it was been reported to be viable up to ten years).

Biocontrol	None known	
Mechanical and cultural	Because common burdock is a biennial that reproduces from seed only, any method which removes the seed source can be effective; including mowing, grazing, hand treatment and tilling.	
Herbicide	Rate	Timing
2,4-D	2 quarts per acre	Apply from the rosette through bolting stages but before flower bud development
Banvel	0.5-1.0 pt product/acre for rosettes less than 3 inches; 1-2 pt product/acre for larger rosettes; 2-3 pt product/acre for bolting plants	Apply to actively growing plants from rosette through bolting stages.
Milestone	4-6 oz/acre	Apply from the late rosette to the late bolting stage.

Common mullein (*Verbascum thapsus*) is found in natural meadows and forest openings, where it adapts easily to a wide variety of site conditions. Prefers, but is not limited to, dry sandy soils. It is intolerant of shade. Primarily a weed of pastures, hay fields, roadsides, rights-of-way, and abandoned areas. Biennial or short-lived perennial. One plant can produce 100,000-180,000 seeds with viability up to 100 years.

Biocontrol	Mullein seedhead weevil (<i>Gymnetron tetrum</i>). Pending approval: mullein moth (<i>Cucullia verbasci</i>)	
Mechanical and cultural	Easy to pull in loose soils because of shallow taproot (before flowering). Hand-hoeing or digging also effective. Mow or scythe just before flowering.	
Herbicide	Rate	Timing
Escort	1 to 1.5 oz per acre	Rosette, before seed sets
Tordon + 2,4-D	2 pints Tordon + 2 pints 2,4-D +MSO +silicone surfactant	
Tordon + Banvel	1.5 pints Tordon + 1.5 pints Banvel + MSO + silicone surfactant	

Curveseed butterwort or bur buttercup (*Ceratocephala testiculata*) is a winter annual that emerges, flowers, and sets fruits in the spring, when temperatures climb into the 45-50 degree range. Plants only grow to be 2 or 3 inches tall. They often occur in dense mats which cover large areas of the ground. At maturity, each blossom develops into a bur, which dries and turns brown, ½ - ¾ inch long.

Biocontrol	None	
Mechanical and cultural	Hoeing, pulling, and digging can control it. Burning is also a good form of control.	
Herbicide	Rate	Timing
2,4-D	1 pint per acre	Pre or post emergent
Roundup	1 to 1.5 pints per acre	
Plateau	4-6 oz per acre	

Field bindweed (*Convolvulus arvensis*) is a perennial and one of the most persistent and difficult-to-control weeds. It has a vigorous root and rhizome system that makes it almost impossible to control with cultivation. Its seed has a long dormancy and may last in soil for up to 60 years. It has a climbing habit that allows the plant to grow through mulches. Field bindweed is also very drought tolerant and once established is almost impossible to control with herbicides. Seeds (viable up to 50 years) and creeping deep roots.

Biocontrol	Leaf-galling mites (<i>Aceria malherbae</i> / <i>A. convolvuli</i>)
Mechanical and cultural	Hand-pulling (and cultivating) must be done for 3 to 5 years every 2 weeks to be effective. Grazing or mowing is not an effective control. Cultivation and herbicide treatment can be used. If herbicides are to be used, treat the bindweed plants before they are drought stressed. Re-treatments will be necessary to control both established plants and seedlings. If possible, grow a competitive planting of other plants to reduce field bindweed growth. Establish and maintain healthy native vegetation, especially perennial grasses.

Herbicide	Rate	Timing
Tordon + 2,4-D	1 to 2 pints Tordon + 1 quart 2,4-D per acre For a 3-gallon backpack: 1 oz Tordon + 2.25 oz 2,4-D per 3 gallons water	
Banvel + 2,4-D	1 quart Banvel + 1 quart 2,4-D per acre For a 3-gallon backpack: 2.25 oz Banvel + 2.5 oz 2,4-D per 3 gallons water	

Houndstongue (*Cynoglossum officinale*) is a biennial or short-lived perennial species which forms rosettes in the first year and flowers in the second. It has a thick branching taproot, extending to depths >40 inches. It often occurs in dense stands. Seedlings are usually clustered around parent plants in densities of up to 405 seedlings per square foot. Estimates of total seed number per plant range from 50 to more than 2,000. Its spiny husk and protruding barbs enable long distance dispersal to occur. Seeds attach to fur and clothing. Seed viability in the soil is relatively short compared to other invasive plants. Seed can remain viable above ground on plants for up to two years. Houndstongue is most abundant in areas with more than 10 percent bare ground. It is toxic to livestock and wildlife. It contains pyrrolizidine alkaloids which cause liver cells to stop reproducing.

Biocontrol	Biological controls are being screened for possible use. One is approved in Canada. A native bacterium is being tested at Montana State University as an effective biological control as well. Spraying the plant with these bacteria interferes with its production of chlorophyll, weakening it so it will not re-sprout the following year.	
Mechanical and cultural	Surface cultivation, digging and hand-pulling are considered ineffective means of control because plants are capable of regenerating from the root crown. Hand pulling can reduce the size of populations up to 85%, though, if roots are completely removed, and hand-pulling occurs before flowering. Severing the root crown 1 to 2 inches below the soil surface with a spade and removing top growth can be effective in controlling small infestations when done before flowering. Mowing at ground level can reduce re-growth by 60% as well as seed production in some cases. Plowing is said to control houndstongue, but may not be appropriate in most areas. A vigorous vegetative cover will help prevent infestations of houndstongue. Houndstongue seedlings have a comparatively low growth rate and are not strongly competitive. Interspecific competition can severely reduce the dry weight of first and second year plants. Therefore, revegetation can effectively control houndstongue re-introduction, although more research is needed.	
Herbicide	Rate	Timing
2,4-D amine	2 quarts per acre In a 3-gallon backpack: 1 oz per 3 gallons water	Before seed set or during fall regrowth
Tordon + 2,4-D	1 pint Tordon + 1 to 2 pints 2,4-D per acre+ MSO + surfactant In a 3-gallon backpack: 1 oz Tordon + 1.12 oz 2,4-D per 3 gallons water	

Escort	0.5 to 1 oz per acre + MSO + surfactant In a 3-gallon backpack: 3/10 oz per 3 gallons water	Rosette to bolt.
Telar	1 oz per acre	In the fall
Plateau	8 oz per acre + MSO	Before seed set or during fall regrowth
Banvel + 2,4-D	Banvel 2 pints/ac + 2,4-D 2 pints+ MSO/acre + surfactant	

Oxeye daisy (*Leucanthemum vulgare*) is a shallow-rooted rhizomatous perennial. The plant is a prolific seed producer; a single, healthy, robust plant produces up to 26,000 seeds. Reproduction occurs primarily through seed dispersal and germination, although spreading rootstalks contribute to its propagation. Seeds may be viable ten days after the flower blossoms and are dispersed close to the parent plant. Germination occurs throughout the growing season, but most new seedlings emerge in spring. Seeds that do not germinate in the spring may remain viable for many years.

Biocontrol	No biological controls have been discovered for oxeye daisy.	
Mechanical and cultural	Oxeye daisy should be mowed as soon as flowers appear to reduce seed production. Mowing may have to be repeated during a long growing season because mowing may stimulate shoot production and subsequent flowering. Root systems are shallow, and the plant can be dug up and removed. Be sure to remove the entire root system, though, as remaining roots may produce new shoots. Hand removal has to continue for several years because seeds may remain viable in the soil for a long time. Where oxeye daisy is already a major member of the plant community, it will increase with continuous cattle grazing. However, oxeye daisy density may be reduced by intensive cattle grazing.	
Herbicide	Rate	Timing
Tordon + 2,4-D	1 pint Tordon + 1 quart 2,4-D per acre For a 3-gallon backpack: 1.0 oz Tordon + 2.25 oz 2,4-D per 3 gallons water	Before seed set
Escort	1 oz per acre	
Tordon	1 to 2 quarts per acre	
Milestone	4-6 oz. per acre	

Priority 4 species

Dyer's woad (*Isatis tinctoria*) can be a winter annual, biennial, or short-lived perennial. Reproduction is by seed. Dyer's woad taproots can reach 3 to 6 feet in depth and branch laterally within the first 12 to 20 inches of soil.

Biocontrol	Rust (<i>Puccinia thlaspeos</i>). Occurs naturally, not currently approved.	
Mechanical and cultural	Hand-pulling, cultivation, or digging below the crown before seed production is very effective. The crown must be removed to prevent re-sprouting. Sheep grazing may also provide limited control of Dyer's woad. Sheep readily consume top growth of woad until the flowering stage. Recent studies suggest that properly timed grazing, repeated several times per season may increase mortality and reduce reproductive performance when at least 60 percent of the plant is removed.	
Herbicide	Rate	Timing
Escort	1/2 oz. per acre + NIS surfactant To minimize seed production on large infestations for about 2 seasons of control.	Best in pre-bloom or early bloom. Can minimize seed production with late application after fruits have begun to form.
2,4-D	1.5-2 qts. per acre	Spring or fall rosette
Telar	1 oz. per acre Registered for use on right-of-ways and in crops; not in rangelands.	Pre- or early post emergent to young plants

Medusahead (*Taeniatherum caput-medusae*) is an annual grass native to the Mediterranean region. Flowering occurs in late spring. The seed heads are what distinguish this plant from other annual grasses. Awns twist as they dry, hence the common name "medusahead". The longer of the two awns in each spikelet is barbed. These barbs catch on fur or clothing and spread seed. Plants invade dry, open lands with frequent disturbance.

Biocontrol	None	
Mechanical and cultural	Although a few reports indicate that medusahead is palatable in early spring before maturity, most grazing animals rarely eat it. Heavy spring grazing by sheep during the green stage of medusahead has been reported to assist in its control. Maintaining good stands of perennial vegetation helps to prevent medusahead invasion, but restoration of most native vegetation without first removing this weed have not been successful. Tillage will control existing medusahead plants and can be used to breakup deep thatch layers. But, it can increase potential for soil erosion and loss of soil moisture. Mowing is not an effective control strategy for medusahead.	
Herbicide	Rate	Timing
Plateau	8 to 12 oz/ac	

Perennial pepperweed (*Lepidium latifolium*) produces dense stands with stems reaching up to 3 feet in height, but even up to 8 feet in wet areas. Its dense cover blocks sunlight from reaching the soil, thus suppressing the growth of other plants. Roots are enlarged at the soil surface in a woody crown and can extend into the water table. The species is a prolific seed producer, capable of producing more than six billion seeds per acre. Seeds lack a hard cover; therefore, viability may be short. In addition to seeds, the species can spread by rhizomes which may grow to a length of ten feet.

Biocontrol	None approved	
Mechanical and cultural	With the exception of continual flooding, no non-chemical treatments have been found to effectively control this species.	
Herbicide	Rate	Timing
Telar or Escort	1 oz/ac	Flower to bud stage
Arsenal	6 to 24 fl oz/ac	

Perennial sowthistle *Sonchus arvensis* is a perennial with thickened rhizomes. Reproducing by rhizomes and by seed (2-5 year viability).

Biocontrol	Cyst-forming nematode (<i>Heterodera sonchophila</i>). Seedhead fly (<i>Tephritis dilacerata dilacerata</i>) waiting for final approval	
Mechanical and cultural	Cutting, grazing, and mowing can be effective at depleting root stores, if done selectively and frequently. Repeated hoeing and cultivating can be effective if done at 6-leaf rosette stage. Establish and maintain healthy native vegetation	
Herbicide	Rate	Timing
Milestone	3-5 oz. per acre	

Plumeless thistle (*Carduus acanthoides*) prefers temperate regions and is frequently found on grasslands. Typically, plumeless thistle inhabits pastures, stream valleys, fields, roadsides, and disturbed areas. A winter annual or biennial herb that has a stout fleshy taproot, plumeless thistle reproduces solely through seed production. During the first growing season, plumeless thistle produces a rosette of leaves and a fleshy taproot. The plant bolts early in the second growing season and flowers from May to August. Seeds are dispersed one to three weeks after flowering, with each flower capable of producing approximately 50 to 80 seeds. Seeds can remain viable for ten years or more.

Biocontrol	Rosette weevil (<i>Trichosirocalus horridus</i>), flea beetle (<i>Psyllodes chalconera</i>), syrphid fly (<i>Cheilosia corydon</i>), thistle-defoliating beetle (<i>Cassida rubiginosa</i>).	
Mechanical and cultural	Hand pulling small infestations of plumeless thistle can be an effective control method. This method should be conducted before the reproductive growth stages of the plant to prevent seed production. Mowing prior to seed dispersal may limit the amount of seed available for germination.	
Herbicide	Rate	Timing
Tordon + 2,4-D	1 pint Tordon + 1 quart 2,4-D per acre	Before seed set or during fall regrowth
Transline	2/3 pint per acre	
Banvel	1 to 1 1/2 pints per acre	
Milestone	3-5 oz. per acre	

Purple loosestrife (*Lythrum salicaria*) is a stout, erect perennial that is usually associated with wetland, marshy, or riparian areas. A mature plant may have as many as thirty flowering stems capable of producing an estimated two to three million seed per year. It also readily reproduces vegetatively at a rate of about 1 foot per year, with root or stem segments forming new flowering stems. The seeds can remain viable even after 20 months of submergence in water. A strong rootstock serves as a storage organ, providing resources for growth in spring and regrowth if the aboveground shoots are cut, burned, or killed by application of foliar herbicides.

Biocontrol	Weevil (<i>Hylobius transversovittatus</i>), black-margined and golden leaf eating beetles (<i>Galerucella californiensis</i> and <i>G. pusilla</i>), flower weevil (<i>Nanophyes marmoratus</i>). The most promising control measure for purple loosestrife is the application of biological agents. Beetle species have been screened as potential control agents and are being studied.	
Mechanical and cultural	Areas of individual younger plants and clusters of up to 100 younger plants can be hand-pulled, if done before flowering. Older plants, especially those in bogs or in deep organic soils, can be dug out. Follow-up treatments are recommended for three years after the plants are removed. Generally, mowing or cutting is not recommended. Where feasible, the flower heads can be cut, bagged, and removed from the site to prevent seed set. Revegetation can be effective.	
Herbicide	Rate	Timing
Rodeo	1 to 1.5% concentrate/ac (1 to 1.5 gal/100 gal water or 1.3 to 1.9 fl. oz. / gal) Spot application to individual is recommended treatment where hand pulling is not feasible. Since purple loosestrife is usually taller than the surrounding vegetation, application to the tops of the plants alone can be very effective and limit exposure of non-target species.	When plants begin to flower
Garlon 3A	1 to 9 lbs ai/ac (1 to 3 gal/100 gal water)	

Quackgrass (*Elymus repens*) is a perennial that propagates mainly by rhizomes but also reproduces by seed. Seed production, however, is reported to be as low as 25 viable seeds per plant per season.

Biocontrol	None known	
Mechanical and cultural	Promote native vegetation that produces shade. Late spring burning. Intensive early spring grazing reduces vigor. Shallow cultivation or plowing in the late fall will expose rhizomes to freezing and drying during winter and reduces the stand and rapidity of spring growth. Intensive grazing before cultural operations are started is beneficial.	
Herbicide	Rate	Timing
Roundup	1-2 qt product/acre for new infestations, 2-3 qt product/acre when quack grass has formed a dense sod.	Apply to early flowering stage or to new growth in the fall

Skeletonleaf bursage (*Ambrosia tomentosa*) is a perennial with deep, creeping rhizomes. Prolific seed producer. It grows primarily on, but not limited to, dry or poorly drained sites.

Biocontrol	No biological controls have been discovered	
Mechanical and cultural	Disking and cultivating are not recommended as they spread root fragments. Hand removal is generally ineffective against species with deep, creeping rhizomes.	
Herbicide	Rate	Timing
2,4-D	1 to 2 quarts per acre	Spring, and again to regrowth in the fall. Actively growing plants.
Picloram	2 quarts per acre	